Synopsis

In our country, due to phenomenal growth in industries and drastic increase in motor vehicles over the decade, the air pollution level has reached alarming limits The air pollution is not only detrimental to human health but also to the eco-system The legislations to control the pollutants are becoming prominent and the stringent emission norms are gradually being enforced in all parts of the world The major air pollutants are oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), hydrocarbons (HC), particulate matter (PM), volatile organic compounds (VOC), aldehydes and alcohols

While the flue gas emissions are successfully controlled, the same is yet to be achieved in the emissions from combustion engines particularly from diesel driven ones The conventional techniques are either difficult to operate or do not meet the stringent emission norms Further, these techniques some times become dangerous to handle and pose problems in disposing the hazardous by-products In addition, the oxygen rich diesel exhaust prevents the reduction of NO_x to the stipulated limits Thus, in case of diesel engines despite the modifications in engine design and improvement in aftertreatment technologies, large amount of NO_x continue to emit and attempts to develop new catalysts to reduce NO_x have been so far less successful Further, the emission standards are becoming more stringent, estimates are that NO_x and particulate emissions must be reduced to as much as 90% from engine-out levels in the 2005-2010 time frame *This has made the researchers across the globe to look for effective non-conventional aftertreatment techniques to reduce the diesel engine emissions*

The electrical discharge plasma (non-thermal plasma) is a prominent non-conventional technique, which can produce chemically active species that can facilitate the removal of NO_x and other pollutants within diesel exhaust Majority of the research has been done on simulated gas or diesel engine filtered exhaust and not much work is reported on the impact of parameters such as exhaust composition and temperature on the NO_x removal efficiency, energy consumption and by-product formation Though the research has also

been carried out on discharge plasma aided catalysis, the results reported have limitations with regard to pollutant removal efficiency, energy consumption and operating temperature window

In the present work, role of exhaust composition in realising effective NO_x removal with reduced energy consumption and minimal by-product formation using the electrical discharge plasma technique has been reported Further enhancement in the NO_x, HC and CO removal efficiencies with subsequent reduction in the by-product formation and energy consumption has been reported using plasma promoted adsorption/catalysis cascaded techniques A prototype of the cascaded system has been developed and tested under actual exhaust conditions

The main objectives of the present thesis are formulated as below

- **To study the impact of diesel exhaust composition on the NO_x removal efficiency, energy consumption and by-product formation in electrical discharge plasma technique**

- **To investigate the NO_x removal performance of plasma promoted adsorption technique, a novel approach initiated in this research work.**

- **To study the NO_x removal performance of two-stage, plasma promoted catalysis using non-conventional inexpensive activated alumina catalyst and to realise high NO_x removal at reduced energy consumption using additional number of stages**

- **To remove NO_x at temperatures at and below 200°C of the exhaust, using plasma promoted catalysis (Vanadium pentaxide catalyst)**

- **To remove simultaneously NO_x and CO from the exhaust of diesel engine, using cascaded plasma-2way catalyst**

- **To develop a prototype of the plasma promoted adsorption/catalysis cascaded system**

The results of the NO_x removal from a stationary diesel engine exhaust have been discussed Both filtered and raw diesel exhaust were treated by the discharge plasma reactor under different loads and temperatures Cascaded plasma-adsorbent reactor (with molecular sieves, activated charcoal and activated alumina as adsorbents) was used to treat diesel filtered exhaust, under different loads and temperatures *This was a novel approach initiated in this research work.* Studies were also conducted using cascaded plasma-activated alumina catalyst and cascaded plasma-vanadium pentaxide catalyst reactor systems In all these cases, HC and aldehydes were also analysed Further, cascaded plasma-2way catalyst reactor system was used for simultaneous removal of NO_x and CO Comparison of different techniques for diesel engine exhaust treatment and comparison of results obtained in the present work with other results available in literature have been made In addition, discharge plasma has been combined with conventional catalytic converter to realise effective NO removal from a gas mixture simulating petrol exhaust at temperatures < 200°C, which is normally encountered in urban duty vehicles Finally, a couple of novel reactor systems were proposed for NO_x removal from various sources

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